RESIDUAL EFFECTS OF SUPPLEMENTAL MOISTURE ON THE PLANT POPULATIONS OF PLOTS IN THE NORTHERN MOJAVE DESERT

R. B. Hunter[1], E. M. Romney[1], A. Wallace[1], and J. E. Kinnear[1]

Abstract.— Residual effects of sprinkle irrigation from 1968–1970 on populations of Mojave Desert shrub communities were observed in late 1974. The sprinkle-irrigated plots showed a residual increase in density of four species, but other species either failed to reproduce in significant numbers or lost all gains made during the years following treatment. The seven-year change for the irrigated plots was equivalent to a gain of 1178 perennial plants per ha, but the nonirrigated plots lost an average of 1050 plants per ha equivalent during the same period. The biomass gain after seven years was equivalent to 1000 kg/ha for irrigated plots and 310 for nonirrigated plots.

This study was made on plots which were established in early 1968 (Wallace and Romney 1972b). The objective of the work reported herein was to measure changes in biomass and density of plant species during a seven-year period that included three years of sprinkle irrigation followed by four years of natural rainfall.

Materials and Methods

The site of the study area is Mercury, Nevada, near the waste water ponds from the local sewage processing system. Close proximity to a source of irrigation water was one prerequisite for the overall research program. The soil at this site is underlain by virtually impervious hardpan at depths varying from 15 to 75 cm. The thickness of the hardpan layer is usually greater than 10 cm. Perennial plants grow both singly and in clumps, separated by bare areas of desert soil. The size and spacing of the clumps are irregular. As many as 10 different species may grow together in a single clump.

A census was made in early spring of 1968 of all perennial plants (including shrubs, grasses, herbs, and their seedlings) in 25 circular experimental plots, each plot being 30.5 m in diameter. Each plant was categorized by species position and dimension analysis. This census effort involved more than 19,000 individual plants representing 28 different species.

A special method was devised for the purpose of locating and cataloging each plant in each plot. A permanent standpipe for mounting a surveyor's transit was installed at the center of each plot, with a marker located on magnetic north at a distance of 15.25 m. Orientation for each vegetational unit (clump) was the measured distance from the plot center to the vegetational unit center. The azimuth to each unit was measured from magnetic north (0°) to the center of the vegetational unit. The unit's greatest and smallest width and its species content were recorded. Each species within a unit was measured in like manner, and it was further identified by height. These data were recorded and transferred to punch cards for computer processing.

For both sprinkler-irrigated and control plots, the height and two widths of each shrub were recorded. From this information shrub volume and biomass were calculated using a dimension measurement regression line (Wallace and Romney 1972a). In November 1974, the census in several plots was repeated and dimensional measurements were also made. Abiotic data obtained from Rock Valley located about 20 km west of the study plots are given in Table 1.

[1]Laboratory of Nuclear Medicine and Radiation Biology, University of California, Los Angeles, California 90024.

RESULTS AND DISCUSSION

Changes induced by supplemental sprinkle irrigation were still apparent four years after the last application of water. In particular, there remained a net gain in population on the watered plots and a net loss on the dry plots after seven years (Table 2).

Population changes depended significantly on species. *Ceratoides lanata* (Pursh) had a much more rapid turnover during the course of the study than did most other species, losing 12 to 36 percent of its population on dry plots while its population increased on irrigated plots. *Sphaeralcea ambigua* A. Gray lost an even higher proportion, 55 to 93 percent on the dry plots, and nearly as much, 47 to 79 percent, on watered plots. Grazing rabbits are especially hard on *S. ambigua*, a preferred food source; therefore, survival data may have little relationship to earlier plot treatment.

The population of *Acamptopappus shockleyi* A. Gray increased on all plots, watered or not. Gains on dry plots ranged from 6 to 55 percent and on watered plots from 8 to 105 percent.

Numbers of *Ambrosia dumosa* (A. Gray) Payne increased slightly on watered plots and decreased slightly on dry plots. This species, especially, showed visible increases in new biomass in response to supplemental moisture.

Other species generally showed negligible changes in populations. For several species this low turnover rate is considered to be significant. *Krameria parvifolia* Benth., *Ephedra funerea* Cov. & Mort., *Ephedra nevadensis* S. Wats., *Yucca schidigera* Roezl ex Ortgies, and *Salazaria mexicana* Torr. must have unusually long life spans if our data are representative. Similarly, their invasion of disturbed sites must be very slow.

The biomass changes by species on these plots are reported in Table 3. In the seven-year period of this study, biomass increased more than 25 percent for 6 species and decreased more than 25 percent for 2 species

TABLE 1. Abiotic factors in the general environs of study plots. Data are from the USWB station located in Rock Valley about 20 km west of Mercury.

	1963–1964	1964–1965	1965–1966	1966–1967	1967–1968	1968–1969	1969–1970	1970–1971	1971–1972	1972–1973	1973–1974	1974–1975	1975–1976
						Rainfall, mm (USWB)							
July	–	20.0	9.1	6.8	7.1	51.0	3.0	10.2	0.5	0.0	0.0	25.6	0.0
August	19.5	8.1	4.8	3.8	50.2	4.3	1.0	22.6	33.3	21.3	3.5	1.6	1.8
September	34.2	0.0	0.0	1.0	10.1	0.0	0.2	0.0	0.0	9.0	0.0	0.0	5.3
October	3.3	4.0	0.7	0.2	0.0	11.6	7.0	0.0	0.0	34.2	3.6	25.9	0.5
November	18.5	3.3	49.2	2.5	28.1	2.5	17.0	19.6	0.8	32.8	15.0	2.5	4.8
December	0.7	0.0	62.4	10.6	10.1	4.3	0.0	17.8	40.6	0.0	12.4	32.8	0.0
January	1.7	10.6	8.8	32.7	1.5	68.0	0.3	0.0	0.0	26.0	34.0	1.0	0.0
February	0.7	0.0	16.2	0.0	30.7	103.0	44.5	8.1	0.0	49.3	1.0	4.1	39.0
March	0.6	12.4	1.2	0.0	7.3	19.0	14.0	1.3	0.0	73.3	6.4	26.9	1.0
April	10.6	60.1	0.7	26.6	5.5	3.0	1.8	0.0	2.0	14.9	0.0	9.9	6.0
May	0.5	2.2	8.6	5.3	0.0	1.0	0.0	19.3	0.0	10.7	0.2	8.1	3.0
June	5.0	0.5	1.7	11.4	3.0	12.0	0.8	0.0	14.5	4.2	0.0	0.0	0.0
						Mean air temperatures (C) USWB							
July	27.2	28.6	26.6	29.1	29.7	28.6	31.1	29.2	30.1	34.1	31.5	30.1	30.6
August	25.8	27.2	25.2	29.4	31.4	23.6	29.7	30.3	28.3	28.3	29.5	28.7	28.8
September	23.9	23.3	21.1	23.6	23.9	23.0	24.9	22.2	22.1	23.9	24.5	27.5	26.8
October	20.5	20.5	19.4	16.9	18.6	17.5	17.2	14.7	16.7	14.2	18.0	17.5	20.3
November	12.7	9.2	12.5	11.1	13.3	12.8	8.4	9.5	6.1	7.9	9.0	10.2	9.0
December	8.3	8.4	8.6	6.1	2.0	3.3	8.4	2.6	4.6	3.8	6.5	3.8	8.1
January	5.3	8.4	0.6	6.7	7.3	7.8	6.4	8.8	6.5	3.1	2.7	4.3	7.8
February	5.0	8.3	5.9	9.5	12.2	2.8	10.3	6.1	11.7	6.9	7.4	5.7	8.9
March	11.7	11.4	13.1	10.8	13.1	13.6	13.1	9.0	19.3	7.0	12.3	7.6	9.9
April	13.6	15.0	16.1	10.0	13.6	16.7	11.1	12.0	16.1	14.4	14.4	9.4	13.1
May	16.4	17.2	20.8	19.4	20.3	22.7	19.2	14.9	20.8	22.5	22.6	19.5	22.8
June	23.0	21.4	25.0	20.3	25.8	23.6	23.9	24.3	27.1	28.0	29.5	26.6	–

on nonirrigated plots. The number of species showing gains in the seven years for the nonirrigated plots was 9; 2 showed neither gain nor loss and 5 species showed losses. In the seven-year study period, biomass increased more than 25 percent for 14 species and decreased more than 25 percent in one species on the irrigated plots. The number of speci showing gains in seven years for the irrigate plants was 16, and one showing a loss. It very clear that irrigation in 1968, 1969, a 1970 resulted in a larger biomass persisti through 1974 ($P < 0.01$ by significance test

TABLE 2. Population changes (averages and standard errors of the means for three plots) in sprinkle-irrigated plo and control plots over a seven-year period (1968–1974). Water was applied to plots in 1968, 1969, and 1970. Area each plot is 730 m^2.

	Start		New		Died		Seven-year change		
Species	Number	SEM	Number	SEM	Number	SEM	Number	SEM	Perce
				Irrigated plots					
A. shockleyi	198	57.7	88.7	19.0	35.0	16.2	+53.7	19.3	+26
A. dumosa	178	3.7	16.3	4.4	4.3	1.2	+12.0	5.5	+6
A. confertifolia	15.3	7.9	1.7	1.7	9.3	4.8	−7.7	4.6	−50
Cactus spp.	3.3	1.5	2.0	1.5	0.0	0.0	+2.0	1.5	+60
C. lanata	129.3	34.9	54.3	23.3	24.7	11.6	+29.7	14.5	+23
C. ramosissima	1.0	1.0	0.0	0.0	0.7	0.7	−0.7	0.7	−70
E. funerea	21.0	7.9	2.0	2.0	0.3	0.3	+1.7	1.7	+8
E. nevadensis	26.3	7.2	3.0	0.6	1.0	0.0	+2.0	0.6	+7
G. spinosa	21.0	7.6	13.3	8.5	2.0	0.6	+11.3	8.1	+53
K. parvifolia	80.3	3.0	2.0	1.0	3.3	1.5	−1.3	2.4	−1
L. tridentata	45.7	8.9	0.7	0.3	1.7	0.3	−1.0	0.6	−2
L. fremontii	4.0	4.0	27.0	13.3	0.7	0.7	+26.3	13.3	+657
L. andersonii	60.3	6.4	1.0	0.6	0.7	0.6	+0.3	0.7	+0
M. tortifolia	9.3	6.4	10.0	2.7	1.3	1.3	+8.7	3.8	+93
M. spinescens	3.0	2.0	5.0	5.0	0.0	0.0	0.0	0.0	0
O. hymenoides	12.3	4.3	2.0	1.5	8.0	2.1	−6.0	1.2	−48
S. mexicana	5.7	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0
S. ambigua	72.3	14.7	22.7	16.3	71.0	28.2	−48.3	14.8	−66
S. pauciflora	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
S. speciosa	0.7	0.7	3.0	0.6	0.3	0.3	+2.7	0.7	+385
Y. schidigera	6.7	0.9	0.7	0.3	0.0	0.0	+0.7	0.3	+10
				Nonirrigated plots					
A. shockleyi	61.0	17.2	21.0	2.3	11.3	5.2	+9.7	2.9	+15
A. dumosa	83.7	10.4	3.3	1.9	4.7	1.8	−1.3	0.9	−1
A. confertifolia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Cactus spp.	1.3	0.7	1.0	1.0	0.7	0.3	+0.3	0.9	+23
C. lanata	273.3	44.2	36.3	12.4	100.3	13.5	−64.0	25.5	−23
C. ramosissima	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
E. funerea	3.7	1.9	1.3	0.3	0.0	0.0	+1.3	0.3	+35
E. nevadensis	4.0	3.1	2.3	0.9	0.0	0.0	+2.3	0.9	+57
G. spinosa	26.3	3.5	9.3	4.1	2.0	1.2	+7.3	2.9	+27
K. parvifolia	22.0	4.6	0.3	0.3	0.3	0.3	0.0	0.6	0
L. tridentata	50.0	10.7	1.0	1.0	1.3	0.9	−0.3	1.8	−0
L. fremontii	0.7	0.7	1.0	0.6	0.0	0.0	+1.0	0.6	142
L. andersonii	36.0	5.1	0.3	0.3	1.0	0.6	−0.7	0.9	−1
M. tortifolia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
M. spinescens	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0
O. hymenoides	6.7	4.0	2.0	0.6	3.0	2.1	−1.0	1.5	−14
S. mexicana	9.0	3.7	0.0	0.0	0.7	0.7	−0.7	0.7	−7
S. ambigua	44.0	7.4	2.0	1.0	30.7	1.5	−28.7	0.7	−65
S. pauciflora	0.7	0.7	0.3	0.3	0.3	0.3	0.0	0.6	0
S. speciosa	20.7	8.1	4.3	1.4	5.7	2.3	−1.3	1.9	6
Y. schidigera	4.0	1.0	0.7	0.7	1.3	0.3	−0.7	0.3	−17

TABLE 3. Biomass and changes in kg/ha (averages and standard errors of the means for three plots) in sprinkle-rrigated and control plots over a seven-year period (1968–1974).

Species	1968 Mean	1968 SEM	1974 Mean	1974 SEM	Seven-year change Mean	Seven-year change SEM	Seven-year change Percent
			Irrigated (n = 3)				
A. shockleyi	104.9	29.6	146.6	33.8	+ 41.7	11.7	+ 39.8
A. dumosa	328.1	66.1	560.9	64.3	+ 237.8	42.5	+ 72.5
A. confertifolia	38.5	22.8	74.4	59.6	+ 36.0	36.8	+ 93.7
C. lanata	152.0	56.0	310.8	111.0	158.8	57.0	+ 104.5
E. funerea	312.1	134.6	372.9	167.8	61.8	48.0	+ 19.8
E. nevadensis	41.1	11.4	68.2	13.4	+ 27.1	5.18	+ 66.0
G. spinosa	40.6	23.2	241.1	149.8	+ 200.5	126.6	+ 494.2
H. salsola	0.13	0.13	2.9	2.9	+ 2.8	2.8	+ 213.9
K. parvifolia	91.8	18.3	117.4	15.4	+ 25.8	4.2	+ 28.1
L. tridentata	211.8	86.5	289.2	133.0	+ 77.4	48.7	+ 36.6
L. fremontii	0.00		11.6	4.9	+ 11.6	4.9	+ ∞
L. andersonii	383.2	53.8	493.9	57.2	110.4	8.0	+ 28.8
M. spinescens	9.7	8.5	16.3	13.3	+ 6.5	4.9	+ 66.7
O. hymenoides	0.24	0.16	0.003	0.003	–0.24	0.16	–100
S. ambigua	2.2	0.44	2.52	1.47	0.28	1.7	+ 12.5
S. speciosa	0	0	0.07	0.07	+ 0.07	0.07	+ ∞
			Nonirrigated (n = 3)				
A. shockleyi	42.0	14.4	53.5	19.2	+ 11.4	4.8	27.2
A. dumosa	201.5	33.0	160.1	53.2	58.7	22.1	29.1
A. confertifolia	0	0	0		0		0.0
C. lanata	557.5	30.2	516.4	66.9	–41.1	37.6	–7.9
E. funerea	25.9	13.4	44.4	23.0	+ 18.5	9.7	+ 71.2
E. nevadensis	33.5	32.2	62.2	59.7	+ 27.8	27.5	+ 83.0
G. spinosa	59.2	18.7	108.8	42.9	+ 70.0	17.8	+ 118.0
H. salsola	0		0		0		0.0
K. parvifolia	44.3	14.4	51.5	15.9	+ 7.3	2.50	+ 16.4
L. tridentata	550.4	56.5	571.7	161.9	+ 120.3	32.6	+ 21.9
L. fremontii	0.03	0.03	0.45	0.27	+ 0.42	0.24	+ 1400
L. andersonii	334.3	30.1	372.9	27.6	+ 38.6	15.7	+ 11.5
M. spinescens	1.12	0.72	0.93	0.67	–0.19	1.0	–17.0
O. hymenoides	0.04	0.02	0		–0.04	0.02	–100
S. ambigua	1.81	0.27	0.31	0.04	–1.50	0.31	–82.9
S. speciosa	0.09	0.05	0.07	0.04	–0.02	0.03	–22.2

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